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Commuting and Reimbursement of Residential Relocation Costs

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Abstract

We develop an equilibrium job search model in which employees incur commuting costs, and residential relocation is costly. We demonstrate that firms partially compensate workers for the incurred relocation costs to avoid paying compensation for commuting costs when house prices do not fully compensate the commuting costs. Taxing reimbursement of relocation costs at a higher rate than reimbursement of commuting costs raises the length of the average journey to work and this tax structure should therefore be avoided if one of the governments' policy objectives is to reduce the (external) costs of commuting.

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1.0 Introduction

In the extensive literature on workers' travel behaviour, it is common to ignore firm decisions on travel behaviour (with the exception of parking policies — see Shoup and Wilson, 1992; Shoup, 1994, and the location of firms). As a result, within the transport economics literature, the theoretical and empirical effects of firm behaviour on workers' transport decisions are little known. As far as we are aware, hardly any attention has been given to the implications of firms' *recruitment policies* for travel behaviour.

In the current paper, we aim to explain the empirical observation that many (private and public) firms reimburse residential relocation costs, which encourages workers to move closer to the workplace (after accepting the job offer). Hence, the length of the commute is affected by firms' recruitment behaviour.

Since the seminal work by Doeringer and Piore (1971), it is common to divide the labour market into primary and secondary labour markets. Primary labour markets refer to the higher segment of the market and the secondary labour market to the lower segment. Typically, in the primary market, employees are higher educated, more specialised, receive higher wages, receive on-the-job training, have more job protection and have more opportunities to move to better paid jobs. In the United Kingdom, 22 per cent of managerial/professional employees, who belong to the primary labour market, receive a contribution to relocation expenses at the moment of recruitment (RCI, 2001). Although we do not have such detailed information for other countries, anecdotal evidence suggests reimbursement of relocation expenses is common in primary labour markets, but probably less so in secondary labour markets. It seems that reimbursement is often institutionalised in collective bargaining agreements in a number of European countries (for example, in the Netherlands, covering about 60 per cent of the employees).[1]

In the United Kingdom, reimbursement of relocation expenses tends to be less common for firms located in London (see Van Ommeren *et al.*, 2006), suggesting that in large metropolitan areas, there is less rationale to reimburse. Anecdotal evidence from the US is that reimbursement only occurs when moving from one metropolitan area to another (that is, when moving from a location from which commuting to the new job is not feasible). In this situation, reimbursement has no, or limited, impact

[1] We have examined the presence of moving costs reimbursement for universities, since employment conditions of universities are publicly available. Many universities publish their employment conditions on internet. A straightforward internet search of the term 'relocation expenses' shows that in the UK, Canada, USA and Australia, reimbursement of relocation expenses by universities is common.

on the length of the journey to work. The observed difference in this respect between the US and, for example, the Netherlands, will be discussed and explained within the theoretical model.

This raises the questions of why firms reimburse residential relocation costs, and why employees, particularly in the primary labour market, receive such reimbursement. Does it depend on the spatial setting and the functioning of the land/house market? Given answers to these questions, we need to know what the consequences of taxes on reimbursement are for commuting behaviour. These issues are relevant from a theoretical and a policy point of view. From a labour economics perspective, reimbursement of residential relocation costs is interesting, because reimbursement cannot be explained in a fully competitive labour market. The most common form of relocation costs reimbursement is that firms offer to reimburse (partially) the relocation costs only if the commuting distance at the moment of application exceeds a certain value. The wage level does *not* depend on whether the worker moves residence. Hence, the total employment costs of workers who receive reimbursement of relocation costs exceeds the employment costs of those workers who do not move, which is inconsistent with the assumption of the perfect labour market.

From a transport policy point of view, reimbursement is interesting, because it shows how *firm* behaviour induces employees to reduce the journey to work by moving residence. This is relevant because the journey to work induces congestion and environmental externalities, whereas moving residence does not. Further, reimbursement is relevant, because reimbursement of residential relocation costs is in some countries treated as taxable income when it exceeds a threshold[2] (for example, in the Netherlands shipping costs plus 5,445 EUR or 12 per cent of annual income), whereas reimbursement of commuting costs is not always taxed (for example, company cars). Taxing reimbursement may be thought to increase average commuting costs and therefore stimulate economic externalities that are related to commuting such as congestion.

The current paper aims to address reimbursement of relocation costs by developing a commuting model which explicitly takes labour market imperfections and wage bargaining between workers and employers into account. The current study makes use of an equilibrium search model, also referred to as a job matching model. Search behaviour of job seekers and employers are both explicitly modelled and residential mobility, commuting costs,

[2]Presumably, such a threshold is imposed to avoid tax evasion (that is, firms pay wages by means of reimbursements). Nevertheless, since we will demonstrate that firms reimburse residential relocation costs for efficiency reasons, it will be inefficient to impose such a low threshold.

wages, number of unemployed and number of vacancies, are endogenously determined. The emphasis of the paper is on an economy assuming homogeneous space. Such an assumption is particularly useful in the context of polycentric urban areas, such as is prevalent in the Randstad in the Netherlands or the Ruhr area in Germany. This assumption will be contrasted with the common (urban economics) assumption that employment is concentrated in employment centres. This assumption is more useful in the context of monocentric non-overlapping urban areas prevalent in the USA, and particularly in Japan (Van Ommeren *et al.*, 1999).

The outline of the current paper is as follows. In Section 2 we employ an equilibrium job search model with homogeneous space, which includes commuting, but excludes residential moving behaviour (see Van Ommeren and Rietveld, 2005). In Section 3, we extend the model by including residential moving behaviour and relocation costs. Section 4 focuses on the tax treatment of relocation costs reimbursement. Section 5 compares the obtained results with a model that assumes that employment is concentrated in one business district. Section 6 concludes.

2.0 The Basic Job Matching Model

2.1 The job matching function

We presume a continuum of identical firms and residences, which are homogeneously distributed over a two-dimensional space. Given homogenous space, there is no reason to expect differences in house prices over space, therefore spatial variation in house prices is assumed to be absent.[3] The economy is closed. Each residence is inhabited by one individual, who is either unemployed or employed. The unemployed search for jobs, the employed do not search (for an equilibrium model which includes on-the-job search, see Mortensen, 1994). The employed incur monetary commuting costs t. The unemployed search throughout geographical space, facing a density of commuting costs $g(t)$. The commuting costs become known at the moment the unemployed job seeker and firm contact each other. A firm consists of only one job, which is either filled or unfilled. In order to fill a job, firms post a vacancy. Firms and individuals are assumed to be risk neutral.

Initially, we presume that workers do not move residence, because residential relocation costs are infinite. Suppose there are L identical

[3] In Section 5, we will make an alternative assumption. We will presume that employment is concentrated in one location, and we allow for house price variation.

individuals in the labour force. We let u denote the unemployment rate and v denote the vacancy rate, defined as number of vacant jobs as a fraction of the labour force L. We assume the existence of a matching technology that gives the number of contacts between unemployed and firms as a function of the number of unemployed uL looking for jobs and the number of firms looking for workers vL. The number of contacts taking place per unit of time is given by $mL = m(uL, vL)$. The matching technology is assumed to be increasing in both its arguments, concave, and having constant returns to scale. Empirical studies generally accept the assumption of an aggregate matching function with constant returns to scale (see Petrongolo and Pissarides (2001)).

Given the matching technology, the probability for a vacancy to be contacted per unit of time, denoted as q, is defined. Given the constant returns to scale assumption, it follows that:

$$q = \frac{m(uL, vL)}{vL} = m\left(\frac{u}{v}, 1\right) = m\left(\frac{1}{\theta}, 1\right),$$

where $\theta = v/u$. So, θ is a measure of labour market tightness, defined as the ratio of the vacancy to the unemployment rate. Thus q, the rate at which vacancies become contacted, depends negatively on the ratio of the vacancy to the unemployment rate, θ, and to emphasise this, we will denote the vacancy contact rate as $q(\theta)$. Similarly, it can be seen that the rate at which unemployed become contacted equals $\theta q(\theta)$, where $\theta q(\theta)$ depends positively on θ.

2.2 Employed and unemployed

Each period an individual receives a wage w and incurs commuting costs t when employed, and receives unemployment benefits z when unemployed. When employed, the commuting costs are exogenous to the worker. In contrast, the wage is endogenous. Given the value of the commuting costs t, firm and unemployed will bargain about the wage w, so $w = w(t)$. The worker will not keep the job forever. The job will be destroyed at rate λ and the worker will then become unemployed. The discount rate is denoted as r.

We denote by U and $W(t)$ the expected (discounted) lifetime income of the unemployed and employed respectively. The lifetime income of the employed can be written as:

$$rW(t) = w(t) - t + \lambda[U - W(t)]. \tag{1}$$

The lifetime income of the employed is equal to the sum of the net wage — the wage minus the commuting costs — and the expected change in lifetime income due to the probability of losing the job. We will show later on that $w(t) - t$ is decreasing in t. This implies that also $W(t)$ is decreasing in t.

When firms and unemployed contact each other, the commuting costs become known and they will form a match when $W(t) > U$. There exists a maximum acceptable commuting cost T, called the reservation commuting cost, at which the unemployed (and the firm) is indifferent between forming a match or continuing searching (for a proof see section 2.5). It follows that only jobs incurring commuting costs less than T are accepted. The fraction of acceptable jobs can be written as:

$$\int_0^T g(t)\,\mathrm{d}t = G(T), \tag{2}$$

where $g(t)$ is the density of commuting costs which reflects the spatial density of jobs. So, the unemployed become employed at rate $G(T)\theta q(\theta)$. When unemployed, the job seeker does not know the value of the commuting costs, implying that the lifetime utility of the unemployed can be written as:

$$rU = z + G(T)\theta q(\theta)[W^e - U], \tag{3}$$

where W^e denotes the conditional expectation of the lifetime income when employed, so $W^e = E(W|t \leqslant T)$. Interpretation of this Bellman equation is as follows: the unemployed receives benefits z and has per unit of time a probability $G(T)\theta q(\theta)$ of becoming employed, and expects to receive an increase in lifetime income equal to $W^e - U$.

2.3 Job creation

The value of a vacancy, V, can be written as:

$$rV = -pc + G(T)q(\theta)[J^e - V], \tag{4}$$

where pc denotes the firm's hiring costs, which are presumed to be proportional to productivity. Vacancies are filled at rate $G(T)q(\theta)$ and J^e denotes the conditional expectation of the job's net worth. The value of an occupied job is equal to the productivity level, denoted as p, minus the wage, $w(t)$, taking into account that with probability λ the job will be destroyed. Hence, the value of the filled job can be written as:

$$rJ(t) = p - w(t) - \lambda[V - J(t)], \text{ or, similarly, } J(t) = \frac{p - w(t) - \lambda V}{r + \lambda}. \tag{5}$$

In equilibrium, all profit opportunities from new jobs are assumed to be exploited, driving rents from vacant jobs to zero, so $V = 0$. This equilibrium condition determines the supply of vacancies, implying that:

$$[r + \lambda]J^e = p - w^e = \frac{[r + \lambda]pc}{G(T)q(\theta)}, \tag{6}$$

where w^e denotes the conditional expectation of the wage. Equation (6) states that the expected net return of the job, $p - w^e$, is equal to the expected capitalised value of the firm's hiring cost. This condition is usually referred to as the job creation condition (Pissarides, 2000).

2.4 Wage determination

Recall that the commuting costs become known at the moment the unemployed job seeker and firm contact each other. The commuting costs are a drawing from a known distribution. Given the commuting costs, the unemployed and the firm bargain about the wage level, and may then accept or reject the match. Following Pissarides (2000), we presume that the wage contract is renegotiable at all times. In equilibrium, job matches yield a local-monopoly surplus. We assume that the total surplus, equal to the sum of the workers' surplus, $W(t) - U$, and the firms' surplus, $J(t) - V$, is shared according to the Nash solution to a bargaining problem, employing the following rule:

$$w(t) = \arg\max[W(t) - U]^{\beta}[J(t) - V]^{1-\beta}, \tag{7}$$

where β is a measure of the workers' labour strength, other than the 'threat points' U and V. It can also be interpreted as the workers' share of the total surplus. We presume that $0 < \beta < 1$. The first-order equation satisfies:

$$W(t) - U = \frac{\beta}{1-\beta}[J(t) - V]. \tag{8}$$

This equation implies that firms and workers agree on which job matches to accept, and which to reject. In equilibrium, $V = 0$, so when J is less than 0, $W - U$ is also less than 0, therefore firms and job seekers agree not to form a match. In contrast, when J exceeds 0, $W - U$ exceeds 0, so firms and job seekers both agree to form a match. When $J = 0$, and therefore $W - U = 0$, firm and job seeker are both indifferent to forming a match or continuing searching.

The wage can then be written as (see Appendix 1):

$$w(t) = [1-\beta][z+t] + \beta p + \beta p c \theta, \quad t \leqslant T. \tag{9}$$

Equation (9) shows that the wage depends positively on commuting costs t. Interpretation of these effects is as follows. Conditional on the commuting costs, firms and job seekers bargain about the wage. The higher the commuting costs, the smaller is the worker's surplus from the match (which is equal to $W(t) - U$), so the worker will ask (and receive) a higher wage to be compensated. This explains why firms compensate commuting costs.

The equation also shows that the wage is increasing in the unemployment benefit level, the productivity level and the average hiring costs per unemployed ($pc\theta$ is equal to the hiring costs times the number of vacancies divided by the number of unemployed, and can be interpreted as the average hiring costs per unemployed). Finally, note that the current interpretation of equation (9) is partial, because θ is an endogenous variable.

2.5 Reservation commuting costs

Job seekers and firms form a match when the commuting costs are less than the reservation commuting costs T. The existence of the reservation commuting costs can be easily shown. The net wage, defined as the wage minus the commuting costs, is decreasing in the commuting costs, since $1-\beta<1$ (see (9)). This implies that lifetime income W is a decreasing function of the commuting costs t (see (1)), which is a sufficient condition for the existence of the reservation commuting costs T. The reservation commuting costs T can be derived by imposing that $W(T)-U$ is equal to 0, so J is equal to 0 (see (8)). The latter condition implies that (see (5)):

$$p - w(T) = 0. \tag{10}$$

So, the firm pays a wage equal to the productivity level, when the incurred commuting costs are equal to the reservation commuting costs. Using the wage equation (see (9)), the reservation commuting costs can be written as:

$$T = p - z - \frac{\beta}{1-\beta} pc\theta. \tag{11}$$

So, the reservation commuting costs are equal to the productivity level minus the unemployment benefits and a share of the average hiring costs per unemployed.

2.6 Equilibrium

In the steady state, the rate of individuals who enter unemployment, $\lambda(1-u)$, must be equal to the rate who would leave unemployment, $uG(T)\theta q(\theta)$. So, the unemployment rate can be written as:

$$u = \frac{\lambda}{\lambda + G(T)\theta q(\theta)}. \tag{12}$$

The expected wage, w^e, can be written as:

$$w^e = [1-\beta][z + t^e] + \beta p + \beta pc\theta, \tag{13}$$

Table 1
Comparative statics of a job search model excluding residential mobility

	T	θ	u	V	G	w^e	t^e
β	?	−	+	?	?	+	?
p	+	+	−	?	+	+	+
z	−	−	+	?	−	?	−
r	?	−	+	?	?	?	?
λ	?	−	+	?	?	?	?
c	?	−	+	?	?	?	?

Note: + = positive; − = negative; ? = ambiguous.

where t^e denotes the conditional expected commuting costs and

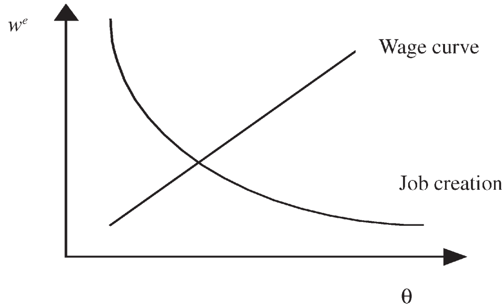
$$t^e = E(t|t \leqslant T) = \frac{\int_0^T tg(t)\,\mathrm{d}t}{G(T)}.$$

The equations (6) and (13) determine θ. This can be demonstrated by incorporating the expected wage equation (13) into the job creation condition (6):

$$[1-\beta][p-z-t^e] - \frac{[r+\lambda]pc}{G(T)q(\theta)} = \beta pc\theta. \tag{14}$$

Equation (14) can be solved uniquely for θ. By differentiating equation (14) with respect to the reservation commuting costs, we find that two effects that T has on it, through t^e and through $G(T)$, cancel each other out, so the value of θ can be shown to be independent of T, an envelope property implied by the optimality of T. Given θ, the reservation commuting costs T are determined (see (11)), and given θ and T, the equilibrium unemployment rate u is determined (12). So, the full equilibrium has been defined. The comparative statics results can be found in Table 1. Proofs can be provided along the lines of Pissarides (2000). For example, the overall effect of unemployment benefits on the expected wage can be demonstrated using Figure 1. The wage curve is an increasing function of labour market tightness, whereas the job creation curve implies a negative relationship between the wage and labour market tightness. The job creation curve does not depend on the unemployment benefits (see (6)), whereas the expected wage curve shifts up when the benefits increase (see (13)). Consequently, the overall effect of higher benefits is an increase in the expected wage. The negative effect on labour market tightness follows from the same figure.

Figure 1
Expected wages and labour market tightness



3.0 The Job Matching Model with Residential Moving Behaviour

3.1 Reimbursement of moving costs

We extend the equilibrium job search model by introducing *residential moves* and residential *relocation costs*, denoted as m. The worker will then either reduce the commuting costs by moving residence at the moment of recruitment, or will not move at all. We presume that the worker can freely choose the new location of the residence. It is optimal for the worker to choose a location as close as possible to the new workplace, so when workers move residence commuting costs will be reduced to zero. We will demonstrate that the decision to move residence depends negatively on the residential relocation costs m and positively on the commuting costs at the moment of recruitment. Workers are partially compensated for the residential relocation costs. It will also be demonstrated that employees move residence when the commuting costs at the moment of application exceed a threshold, denoted as T^*. One of the consequences is that a contact generates a job match, either not accompanied by a residential move (when $t \leqslant T^*$) or accompanied by a residential move (when $t > T^*$).

It can be seen that T^*, defined as the *minimum commuting costs that trigger a residential move*, must be smaller than the reservation commuting costs T, which are defined as the maximum commuting costs when residential moves are inhibited; that is, when residential relocation costs are infinite. The proof is as follows. Presume that $T^* > T$, so job contacts implying commuting costs between T^* and T will be rejected, whereas contacts implying commuting costs larger than T^* will lead to a job match. Such behaviour is clearly irrational, implying that $T^* \leqslant T$.

We will use subscripts m and s to indicate the choice between moving or staying. Given the opportunity to move residence the lifetime income of the unemployed can be written as:

$$rU = z + \theta q(\theta)[W_m - U - m]H(T^*) + \theta q(\theta)[W_s^e - U][1 - H(T^*)], \quad (15)$$

where W_m denotes the lifetime income when the newly employed worker moves residence and W_s^e denotes the expected lifetime income when the worker stays in the same residence, and where $H(T^*)$ denotes the probability of moving residence given a job contact. So, $H(T^*) = 1 - \int_0^{T^*} g(t)\,\mathrm{d}t$. Let w_m and w_s denote the wage of movers and stayers respectively. So,

$$rW_m = w_m + \lambda[U - W_m], \quad (16)$$

and

$$rW_s(t) = w_s(t) - t + \lambda[U - W_s(t)], \quad (17)$$

and thus

$$rW_s^e = w_s^e + \lambda[U - W_s^e], \quad (18)$$

where w_s^e denotes the expected wage of stayers, and where the expectation is taken with respect to the (*a priori* unknown) commuting costs.

The newly recruited worker will move residence when $W_m - m \geqslant W_s(t)$. The value of T^* is determined by the condition $W_m - m = W_s(T^*)$. Using equations (16) and (17), this condition implies that:

$$w_m - w_s(T^*) = [\lambda + r]m - T^*. \quad (19)$$

Consequently, when the employee is indifferent between moving or staying, the wage 'premium' received by movers equals the capitalised relocation costs minus the commuting costs. Suppose again that given a job contact, the unemployed and firm bargain about the wage following the Nash solution to a bargaining problem, so similar to (7), it follows that

$$w_s(t) = \arg\max[W_s(t) - U]^{\beta}[J_s(t) - V]^{1-\beta},$$

and also that

$$w_m = \arg\max[W_m - U - m]^{\beta}[J_m(t) - V]^{1-\beta}.$$

It can be shown that (see Appendix 2):

$$w_m = [1 - \beta]z + [1 - \beta][r + \lambda]m + \beta p + \beta pc\theta, t \geqslant T^* \quad (20)$$

$$w_s(t) = [1 - \beta][z + t] + \beta p + \beta pc\theta, t \leqslant T^*. \quad (21)$$

Equation (20) indicates that the wage of movers does not depend on the commuting costs t at the moment of the job contact. It indicates that the firm will partially reimburse the relocation costs, and reimbursement is equal to $[1 - \beta][r + \lambda]m$, where $[r + \lambda]m$ denotes the capitalised relocation costs. *Hence, firms partially compensate workers for the incurred relocation costs to avoid paying compensation for commuting costs.*

One interpretation of (20) seems to be that workers pay for the relocation costs m upfront, and are compensated by means of a higher wage equal to a share $[1-\beta]$ of the capitalised relocation costs, $[r+\lambda]m$. So, the wage is the same each period until the worker is fired. Recall that workers and firms are risk neutral. An alternative interpretation to the wage bargaining problem is thus that firms pay once $[1-\beta]m$ to the relocated worker at the moment of recruitment, and pay no compensation as part of the wage in later periods. Which of the interpretations is correct? It appears that the first interpretation is not correct, because the employed individual's bargaining position after the first period of employment is weakened because after the move the commuting costs are zero (this can be easily seen as $w_m > w_s(0)$, so $W_m > W_s(0)$). The moving costs are effectively sunk and do not play any further role in the bargaining process. The model implies that relocation compensation is paid once upfront, because the worker realises that after accepting the job and moving residence, the moving costs are sunk and the wage will be reduced to the level consistent with zero commuting costs. The interpretation of (21) is identical to the interpretation of (9). We can summarise the above as follows:

Proposition 1 *In a labour market with homogeneous space, search imperfections, commuting and bargaining, firms will partially reimburse workers upfront for their moving costs to avoid paying compensation for commuting costs.*

We argue that the assumption of negotiable contracts induces upfront reimbursement of moving costs. In the case of non-negotiable contracts however, firms may also choose to pay each period $[1-\beta][r+\lambda]m$, so workers bear all the risk. We will focus here on two possible extensions, which are beyond the remit of this paper. One possible extension of the model is then to assume that firms are risk neutral, whereas workers are risk averse (Milgrom and Roberts, 1992). This assumption also implies that larger firms compensate relocation costs upfront, whereas smaller firms do not. Another possible extension is to allow for search on the job (Pissarides, 2000). In this case, one expects that firms are not willing to bear all the risk, due to adverse behavioural effects of workers, so firms may demand that the reimbursement is returned if the worker leaves within a certain period.

Equations (20) and (21) imply that $w_m - w_s(T^*) = [1-\beta][\lambda+r]m - [1-\beta]T^*$. Combining this result with equation (19) implies that $w_m - w_s(T^*) = 0$. It follows, using equation (19), that T^*

can be written as:

$$T^* = [\lambda + r]m. \tag{22}$$

It appears that T^* has a straightforward interpretation which we state as follows:

Proposition 2 *In a labour market with homogeneous space, search imperfections, commuting and bargaining, the minimum commuting costs that trigger a residential move are equal to the expected capitalised relocation costs.*

This proposition implies that the minimum commuting costs that trigger a move T^* are an increasing function of λ, r and m.[4] Equation (22) has a number of interesting implications: First, $T^* = 0$ if $m = 0$. Hence, the commuting costs are zero when moving costs are absent, showing that given homogeneous space, non-zero commuting costs are the result of the combination of the presence of residential moving costs and frictions in the labour market, since job offers come from a spatial distribution. Second, to the extent that the discount rate is positively related to the real interest rate, it appears a lower real interest rate induces workers to commute less and to move residence more frequently. Third, in labour markets where jobs are more often destroyed (λ is high), so job turnover is high, T^* will be higher and moving residence closer to the job will occur less often. Fourth, $H(T^*)$ depends negatively on $g(t)$ (which can be easily seen since T^* does not depend on $g(t)$). Hence, in labour markets where the spatial density of jobs is high, moving residence to reduce the commuting costs occurs less often.

One implication of Proposition 1 is that reimbursement of relocation costs is less than the full costs of moving residence. For example, given $\beta = 0.5$ (which is a common assumption in the literature), reimbursement is about half of the full relocation costs. Interestingly, the model suggests that if labour markets are more competitive (so β is higher and workers are paid (close to) the marginal productivity level), compensation for moving costs is less. This probably contributes to the explanation of why reimbursement of moving costs is mainly documented for managerial and professional employees employed in primary markets, and less for manual employees.

Proposition 2 implies also that employees in primary labour markets (the higher segment of the labour market) are more likely to receive

[4] This suggests that in countries where residential relocation costs are high and job turnover is high (in the current model captured by λ), commuting costs tend to be higher.

reimbursement of moving costs. In secondary labour markets, λ tends to be large (workers have less job protection, so are more often fired) and $g(t)$ tends to be large (the job density is higher, since jobs are more homogeneous). Thus, the expected capitalised relocation costs and therefore the maximally acceptable commuting costs are higher, so in secondary markets moving residence to reduce the commute will occur less often, because moving residence is too risky (λ is large) and the probability of finding a job close to the residence is higher ($g(t)$ is large). Summarising, in secondary labour markets, reimbursement of moving costs is less common, because these markets are more competitive, job turnover is higher and the density of jobs is higher in these markets.

3.2 Equilibrium

The equilibrium, presuming $T^* < T$, is further characterised as follows. The unemployment rate equilibrium and the job creation condition can be derived in the same way as in the previous section, the only difference being that $G(T) = 1$, because all job offers are accepted. Hence,

$$u = \frac{\lambda}{\lambda + \theta q(\theta)}, \tag{23}$$

and

$$p - w^e = \frac{[r + \lambda]pc}{q(\theta)}, \tag{24}$$

where as before the net return of the job is equal to the expected capitalised value of the firm's hiring costs. It follows still that the expected wage is a negative function of labour market tightness θ, so firms will open less vacancies if the expected wage is higher. The expected wage equation is now equal to the weighted average of the wage received by movers, w_m, and the expected wage of stayers, w_s^e, where the weights are determined by the probability of moving residence $H(T^*)$. Hence:

$$w^e = H(T^*).w_m + [1 - H(T^*)]w_s^e. \tag{25}$$

Using (21), the expected wage of stayers, w_s^e, can be written as:

$$w_s^e = [1 - \beta][z + t_s^e] + \beta p + \beta pc\theta. \tag{26}$$

Here, t_s^e denotes the expected commuting costs of stayers, and is defined as follows:

$$t_s^e = E(t|t \leqslant T^*) = \frac{\int_0^{T^*} tg(t)\,\mathrm{d}t}{1 - H(T^*)}. \tag{27}$$

Given (25), the expected wage can be written as:

$$\begin{aligned} w^e &= [1-\beta]z + \beta p + \beta pc\theta + H(T^*)[1-\beta][r+\lambda]m + [1-H(T^*)][1-\beta]t_s^e \\ &= [1-\beta]\left[z + \int_0^{T^*} tg(t)\,\mathrm{d}t\right] + \beta p + \beta pc\theta + H(T^*)[1-\beta][r+\lambda]m, \quad (28) \end{aligned}$$

where $T^* = [\lambda + r]m$. So, it follows from (28) that the expected wage w^e is an increasing function of θ (see Figure 1) and both are uniquely determined.

The equilibrium values of T^*, $H(T^*)$ and t_s^e are easily determined and do not need more explanation. Equilibrium is therefore essentially a triple (u, θ, w^e) that satisfies the flow equilibrium condition (23), the job creation condition (24), and the expected wage condition (28). Equations (24) and (28) determine the expected wage w^e and θ, the ratio of vacancies to unemployment; given the ratio of vacancies to unemployment, equation (23) determines unemployment.

3.3 Comparative statics

To analyse the effect of changes in the residential relocation costs, we note that an increase in residential relocation costs increases the expected wage w^e (see (28)) but does not affect the job creation condition directly (24). So, in equilibrium, an increase in residential relocation costs decreases labour market tightness (see Figure 1), and increases the unemployment rate (see (23)). This prediction is in line with the observation that in European countries, compared to the United States, high levels of structural unemployment go together with low residential mobility rates.

T^* exists only when $T^* < T$. The condition $T^* < T$ implies that

$$[r+\lambda]m < p - z - \frac{\beta}{1-\beta}pc\theta,$$

see equations (22) and (11). If this condition is not fulfilled, irrespective of the commuting costs, workers will not move residence, because the capitalised residential relocation costs exceed the increase in lifetime utility of becoming employed (so $W(t) - U - m < 0$). Hence, when relocation costs are 'too high', firms will not compensate relocation costs, and job seekers and firms will not form a match when commuting costs exceed T (see Section 2).

The full comparative statics results can be found in Table 2. The effects of the model including residential mobility (Table 2) are, in many cases, more precise than the model excluding residential mobility (Table 1). For example, including residential mobility, an increase in the productivity level unambiguously increases the number of vacancies, whereas excluding residential mobility, the effect is ambiguous (see Pissarides, 2000, p. 163 and

Table 2
Comparative statics of a job search model including residential mobility

	T^*	θ	u	V	H	w^e	t^e
β	0	−	+	−	0	+	0
p	0	+	−	+	0	+	0
z	0	−	+	−	0	+	0
r	+	−	+	+	−	?	+
λ	+	−	−	?	−	?	+
c	0	−	+	−	0	?	0
m	+	−	+	?	−	+	+

Note: + = positive; − = negative; ? = ambiguous.

p. 222, for similar results when introducing stochastic job matching). The most interesting finding is that the effects of the structural parameters on the expected commuting costs are different. Given the opportunity to move residence (that is, relatively low relocation costs), the expected commuting costs depend merely on three parameters (λ, r, m) and do not depend on labour market variables such as the productivity level. In contrast, when workers do not have the opportunity to move residence (that is, relatively high relocation costs), it is plausible that the productivity level is one of the main determinants of the expected commuting costs (see equation (11)). This finding suggests that the relationship between the journey to work and productivity depends strongly on the residential relocation costs.

4.0 Tax Treatment of Reimbursement of Relocation Costs

Until now, we have ignored the tax treatment of wages and compensation for commuting and relocation costs.[5] Let us suppose that all these payments are taxed at the same marginal tax rate, η. In this case, it can be easily shown that the consequences for the labour market outcomes (unemployment, vacancies, and wage) are identical to the standard model, which excludes commuting and moving as described in Pissarides (2000, p. 307). Because the reimbursements of commuting and moving are taxed at the same rate, the probability of moving residence is not affected by the tax.

[5] Taxes on fringe benefits tend to be less than taxes on wages, which gives an incentive to firms to compensate workers by means of fringe benefits (Lazear, 1998). Note that when once-only reimbursement payments of relocation costs are not taxed, whereas wages are, then it is plausible that workers are compensated upfront.

Let us now focus on the case that $\eta_m \neq \eta_c$, where η_m, η_c denote the marginal tax on reimbursement of moving and commuting costs respectively. In this case, it can be shown that the probability of moving residence can be written as: $\Pr(t/[1-\eta_c\{1-\beta\}] > T^*)$, where $T^* = (\lambda + r)m/(1-\eta_m[1-\beta])$. Clearly, if $\eta_c > \eta_m$ then the tax system encourages workers to move, if $\eta_c < \eta_m$ then the opposite occurs.

In many countries, reimbursement of relocation costs is accepted as a non-taxable fringe benefit under specific circumstances (for example, the worker must have moved residence closer to the workplace) up to a certain threshold. In some countries the threshold is low. For example, in the Netherlands, the average relocation costs (of owners) are about three times as high as the threshold. As mentioned in Section 1, in the Netherlands the threshold is maximally 5,445 Euro. The average value of a dwelling is close to 150,000 Euro, whereas monetary relocation costs due to transaction taxes are at least 10 per cent of the value of the dwelling. At the same time, in many countries, one of the most important ways of commuting compensation for workers is by means of a company car. Taxation of company cars depends predominantly on the value of the car and not on the commuting distance, so commuting costs are effectively not taxed. Let us suppose therefore that $\eta_c = 0$ and $\eta_m > 0$, so only the moving costs are taxed. In this case, the once-only relocation costs reimbursement paid by firms is equal to $[1-\beta]m/(1-\eta_m[1-\beta]) > [1-\beta]m$ (see Appendix 3), so workers receive $[1-\eta_m][1-\beta]m/(1-\eta_m[1-\beta]) < [1-\beta]m$. Consequently, the tax system increases the firms' employment costs, whereas the employee's after-tax reimbursement falls, which explains why the average commute increases. Further, presume that $\eta_m = 0.5$ (which is relevant for the Netherlands) and $\beta = 0.5$ (which is a common assumption). In this particular case, $T^* = 4/3(\lambda + r)m$, so the tax on reimbursement increases the minimum commuting costs that trigger a residential move by about 33 per cent (given the assumption that T^* is less than T, so moving is also an option given the tax). The average commuting costs (including the movers) are equal to

$$\int_0^{T^*} tg(t)\,\mathrm{d}t + H(T^*).0 = \int_0^{T^*} tg(t).$$

Given two-dimensional space, $g(t) = \alpha t$, where $\alpha > 0$. Hence, the average commuting costs are equal to $(\alpha/3)T^{*3}$. So, in this model the average commute approximately doubles due to the tax structure, which is substantial (since $(4/3)^3 \approx 2$). This implies that a relatively small increase in T^* may induce a large increase in the average commute. This occurs because a residential move induces the highest commuting costs to become zero, and because space is two-dimensional, so a small increase in T^* has a disproportional effect on the average commute.

5.0 Non-homogeneous Space and House Prices

We have assumed above that space is homogeneous. We have argued that given this assumption it makes sense to assume that spatial variation in house prices is absent. Hence, workers will *not* be compensated for their commuting costs in the housing market. This assumption may be contrasted with another assumption common in urban economics literature, which holds that in urban areas, employment is concentrated in one area (the Central Business District), which is surrounded by a residential area. Suppose now free residential mobility of workers. In this case, it is generally true that workers who live further away from the employment centre are *fully* compensated by lower house prices (Fujita, 1989).

Let us suppose now that we make exactly the same assumptions about the labour market as in Section 2, where we derived the wage equation, given the absence of residence mobility. Now instead we follow Wasmer and Zenou (2002) and presume that employment is concentrated in one employment centre and house prices are endogenously determined. Furthermore, and this is also fundamentally different, the residence location is freely chosen by employed and unemployed workers (so moving costs are zero). It can then be easily seen that the employed choose to live closer to the employment centre than the unemployed (the employed have a reason to be closer to the employment centre, whereas the unemployed have not). Furthermore, it appears that:

$$w = [1-\beta]z + \beta p + \beta pc\theta + [1-\beta]t_d, \tag{29}$$

where t_d is defined as the commuting costs paid by the worker who lives the furthest away from the employment centre ((29) is implied by Wasmer and Zenou, 2002). Hence, in contrast to (9), the wage does *not* depend on the commuting costs t (note that the wage depends on t_d, which measures the size of the urban area, but not the location of a worker). This makes sense as workers are *fully* compensated by lower house prices in the housing market.

Recall that Proposition 1 claims that firms reimburse workers for their moving costs to avoid paying compensation for commuting costs. When house prices fully compensate for commuting costs, then commuting compensation does not occur, however (see (29)). Hence, reimbursement of relocation costs will not occur provided that the presence of moving costs does not affect the spatial variation in house prices (this is a reasonable assumption; see Fujita, 1989). We arrive at the conclusion that only if house prices fully compensate, then Proposition 1 does not hold.[6] This may explain why in London, where the house price gradient is steeper, reimbursement of location expenses is less common than the rest of the UK (see Van Ommeren *et al*., 2006). The novelty of our approach, compared to for example, Wasmer and Zenou (2002), is that we allow for positive moving costs and do *not* allow for house price compensation. Note further that Wasmer and Zenou (2006) allow for positive relocation costs (and house price compensation), but assume in that context that firm compensation for moving costs is absent, so they do *not* study the determinants of relocation costs reimbursement.

Consider now a multiregional structure where in each region employment is concentrated in the centre. Then one may expect that *reimbursement of residential relocation costs does not occur when a worker moves closer to the workplace within the same urban area*, because a reduction in commuting costs is fully compensated via increased house prices. However, *reimbursement is expected to occur when a worker moves interregionally* (see Zax, 1994, for a more general view on the distinction between intraregional and interregional mobility). Such a prediction is in line with anecdotal evidence for the US.

Consequently, we conclude that reimbursement of location costs depends *strongly* on the spatial setting. To be more precise, reimbursement should be less common for moves *within* (large non-overlapping) metropolitan areas than in other areas, because in these areas, the house price gradient is rather steep. This conclusion turns out to be consistent with empirical evidence for the UK (see Van Ommeren *et al*., 2006). Note that in the US many moves are within large metropolitan areas, so reimbursement of moving costs should be less common than, for example, in the Netherlands in line with anecdotal evidence.

6.0 Conclusion

We set out to analyse the effects of residential relocation costs on workers' compensation, aiming to explain the observation that firms compensate residential relocation costs particularly in primary labour markets (RCI,

[6]Note that there is a large theoretical and empirical literature that shows that full compensation by house prices does not occur for a number of reasons, uncertainty about the location of future employment probably being one of the main reasons (Crane, 1996).

2001), but less so for moves within large metropolitan areas (Van Ommeren *et al.*, 2006). Hence, spatial structure is essential to the understanding of residential costs reimbursement. We argue that competitive labour markets combined with reduced tax rates on reimbursement of moving costs relative to wages may not fully explain this observation. We demonstrate that given labour market imperfections firms partially compensate workers for the incurred relocation costs to avoid paying compensation for commuting costs when house prices do not fully compensate for the commuting costs. Our model is consistent with the observation that firms pay the compensation upfront. One of the major consequences is that an increase in residential relocation costs increases average commuting costs (and the equilibrium unemployment rate). Therefore we have shown that firm recruitment behaviour influences commuting behaviour. In the case that relocation costs are 'too high', firms do not compensate relocation costs, and firms and unemployed workers agree not to form a match, implying a higher equilibrium unemployment rate. Our model predicts further that reimbursement of relocation costs occurs particularly in primary labour markets, but less so in secondary markets.

Especially in countries where cities are (relatively) small and close to each other, and house prices are unlikely to compensate for the commuting costs, taxing reimbursement of relocation costs at a higher rate than reimbursement of commuting costs will increase the length of the average journey to work. The main policy implication is that this tax structure should therefore be avoided if one of a government's policy objectives is to reduce the (external) costs of commuting. The journey to work causes congestion and environmental externalities, whereas moving residence does not.

Another more general implication is that we show the importance of *firm* behaviour for transport decisions of workers. Firms are expected to influence these decisions via their parking and compensation/recruitment policies. Firms may compensate workers for commuting by means of higher wages, the use of company cars, or by paying relocation reimbursement costs. In the current paper, we have focussed on the reimbursement of relocation costs. We believe that the effects of firm behaviour on commuting patterns may be substantial. They have received little attention in theoretical and applied empirical research and therefore require more attention.

References

Crane, R. (1996): 'The Influence of Uncertain Job Location on Urban Form and the Journey to Work', *Journal of Urban Economics*, 37, 342–56.

Doeringer, P. and M. J. Piore (1971): *Internal Labour Markets and Manpower Analysis*, Lexington.
Fujita, M. (1989): *Urban Economic Theory*, Cambridge University Press, Cambridge.
Lazear, E. P. (1998): *Personnel Economics*, MIT Press, Cambridge, Massachusetts.
Milgrom, P. and J. Roberts (1992): *Economics, Organisation and Management*, Prentice Hall, New Jersey.
Mortensen, D. T. (1994): 'The Cyclical Behavior of Job and Worker Flows', *Journal of Economic Dynamics and Control*, 18, 1121–42.
Pissarides, C. A. (2000): *Equilibrium Unemployment Theory*, MIT Press, second edition, Cambridge.
Petrongolo, B. and C. A. Pissarides (2001): 'Looking into the Black Box: a Survey of the Matching Function', *Journal of Economics Literature*, 49, 390–431.
RCI (2001): *Recruitment Confidence Index*, Cranfield School of Management, United Kingdom, December.
Shoup, D. C. and R. W. Wilson (1992): 'Employer-paid Parking: the Problem and Proposed Solutions', *Transportation Quarterly*, 46, 2, 169–92.
Shoup, D. C. (1994): 'Cashing out Employer Paid Parking: the Precedent for Congestion Pricing?' *Transportation Research Board Special Report*, 242.
Van Ommeren, J. N., P. Rietveld, and P. Nijkamp (1999): 'Job Moving, Residential Moving and Commuting: a Search Perspective', *Journal of Urban Economics*, 46, 230–53.
Van Ommeren, J. N. and P. Rietveld (2005): 'The Commuting Time Paradox', *Journal of Urban Economics*, 58, 437–54.
Van Ommeren, J. N., A. Van der Vlist, and P. Nijkamp (2006): 'Transport-related Fringe Benefits: Implications for Moving and Journey to Work', *Journal of Regional Science*, forthcoming.
Wasmer, E., and Y. Zenou (2002): 'Does City Structure Affect Job Search and Welfare?' *Journal of Urban Economics*, 51, 515–41.
Wasmer, E. and Y. Zenou (2006): 'Equilibrium Search Unemployment with Explicit Spatial', *Labour Economics*, forthcoming.
Zax, J. S. (1994): 'When is a Move Migration?' *Regional Science and Urban Economics*, 29, 153–65.

Appendix 1

Derivation of the wage (given the absence of residential mobility)
Equations (6) and (8) imply that:

$$W^e - U = \frac{\beta}{1-\beta}\frac{pc}{G(T)q(\theta)}, \tag{A1}$$

whereas equations (3) and (A1) imply that:

$$rU = z + \theta\frac{\beta}{1-\beta}pc. \tag{A2}$$

Hence, equation (1) can be rewritten as:

$$W(t) - U = \frac{w(t) - t - rU}{r + \lambda} = \frac{w(t) - t - z - \theta \frac{\beta}{1-\beta} pc}{r + \lambda}. \tag{A3}$$

Making use of equations (5), (8) and (A3) and noting that $V = 0$ reveals that:

$$\frac{w(t) - t - z - \theta \frac{\beta}{1-\beta} pc}{r + \lambda} = \frac{\beta}{1-\beta} \frac{p - w(t)}{r + \lambda}. \tag{A4}$$

Reordering of the last part of the equation, gives wage equation (9).

Appendix 2

Derivation of the wage given residential mobility

For workers who do not move residence, note that $J_s(t) = J(t)$ and $W_s(t) = W(t)$, where $J(t)$ and $W(t)$ are defined by (5) and (1). Thus, equation (21) follows in the same way as equation (9). For movers, W_m is defined in the main text by (16) and $J_m = [p - w_m]/[r + \lambda]$. Note further that (15) can be rewritten as:

$$rU = z + \theta \frac{\beta}{1-\beta} pc, \tag{B1}$$

because, in a similar way as the derivation of (A1), it is true that:

$$w_m - U - m = \frac{\beta}{1-\beta} \frac{pc}{H(T^*)q(\theta)}, \tag{B2}$$

and

$$w_s^e - U = \frac{\beta}{1-\beta} \frac{pc}{1 - H(T^*)q(\theta)}. \tag{B3}$$

In the same way as Appendix 1, it appears then that:

$$\frac{w_s(t) - t - z - \theta \frac{\beta}{1-\beta} pc}{r + \lambda} - m = \frac{\beta}{1-\beta} \frac{p - w_s(t)}{r + \lambda}, \tag{B4}$$

hence (20) follows.

Appendix 3

Reimbursement including taxation

Let us focus on an optimally chosen once-only reimbursement, which we will denote by τ, which will be paid to a worker who moves. In this case, we may set the commuting costs to zero (because these costs are equal to zero after the move) and proceed by assuming that the wages (excluding the reimbursements τ) and the reimbursement τ are optimally set (in essence the firm has two instruments: the wage and the once-only reimbursement of moving costs, which are optimally chosen). So,

$$\tau = \arg\max[W(0) - U - m + [1 - \eta_m]\tau]^{\beta}[J(0) - V - \tau]^{1-\beta}, \qquad \text{(C1)}$$

where $V = 0$. Because the wage (excluding the reimbursement) is optimally set, the following condition holds for moving and non-moving workers: $W(0) - U = \beta/[1 - \beta]J(0)$. Hence, it follows that the optimally chosen reimbursement $\tau = [(1 - \beta)/1 - \eta_m(1 - \beta)]m$.